About the Presenter

Mike Gibbs, together with his partner Joanie Gibbs, own and operate Rigging for Rescue (technical ropework seminars and consulting) located in Ouray, Colorado. Mike is a full-time rope rescue instructor, part-time climbing guide, and volunteer member of the Ouray Mountain Rescue Team.
“High-modulus aramid fiber friction hitches in technical rope rescue systems”

Author: Mike Gibbs, Rigging for Rescue

Abstract:

Background

Increasingly, rope manufacturing companies are incorporating aramid fibers into products intended to be configured as friction hitches. Two examples include: (1) Sterling Rope RIT 900 cord as well as their sewn Hollow Block loop which is constructed out of the same RIT 900 cord and (2) the VT Prusik – manufactured by BlueWater Ropes – a kernmantle constructed Nylon core and aramid fiber sheath product used to configure a variety of friction hitches.

Traditionally, the most commonly employed friction hitch in technical rope rescue has been the 3-wrap Nylon Prusik using 8mm accessory cord. This material and hitch configuration is used in many applications such as rope grabs in pulley systems, transfer-of-tension devices, and personal edge restraint systems. Additionally, many rescue teams use the Nylon Prusik hitch in tandem as a rescue belay system.

The introduction of aramid fibers into the materials used to configure friction hitches creates some obvious questions as to the appropriateness of use in rope rescue. For example, “can these aramid fiber friction hitches replace the traditional 8mm Nylon 3-wrap Prusik in all commonly used applications?”

Over the past year, Rigging for Rescue has conducted numerous slow pull and drop test examinations of aramid fiber friction hitches on a variety of host rope types commonly used in technical rope rescue. A summary of the results is included in this study.

Results

In test examinations using a hydraulic ram ‘slow pull machine’, the Sterling Hollow Block and tied RIT 900 cord both configured as 3-wrap Prusik hitches were able to hold a higher force prior to slipping than a similarly configured 8mm Nylon Prusik hitch. However, when they did slip it often resulted in visible damage to either the hitch material itself or the host rope. The forces required to generate such a slip were of a magnitude that would be - for all practical purposes - unachievable in a Mainline rope rescue operation (i.e. slow pull).

Slow pull examinations of the BlueWater VT Prusik - configured as an asymmetrical friction hitch - also held high forces prior to slipping, but with negligible hitch material and/or host rope visible damage.

Both the Sterling and BlueWater products were also examined on the drop tower in a shock load capacity using the BCCTR Belay Competence Drop Test Method for rope rescue systems. The number of tests conducted would qualify as ‘quick look’ in nature, but some interesting results were observed nonetheless.

Conclusions

Aramid fiber friction hitches offer some worthwhile applications in a number of common rope rescue scenarios. However, there are also some applications of use in which these same friction hitches appear to have small margins between positive and negative results. It would seem prudent to proceed cautiously in substituting aramid fiber friction hitches in all similar applications that have historically been fulfilled by 8mm Nylon Prusik hitches. Certainly, more testing should be conducted prior to adopting such changes – particularly so in positions of use involving dynamics such as a rescue belay system.
Aramid Fiber Friction Hitches in Rope Rescue Systems

Mike Giblin, Rigging for Rescue
T/A/2014
Golden, Colorado

Our research question:
"Can these aramid fiber friction hitches replace the traditional 8mm Nylon 3-wrap Prusik in all commonly used applications in rope rescue?"

- Mainline rope grab
- Permanently restrained system
- Rappel backup device
- Rescue ladder

What information do we have to share?
- Slow pull testing results
- Drop testing results
- Anecdotal observations

Slow pull testing
- Hydraulic ram slow pull machine
- Data captured with a load cell set for 600 Hz
- Test stopped at initial slip (mostly)
- Combination of new/used materials
- 48 tests conducted

Summary Data – Nylon 3-wrap Prusik

<table>
<thead>
<tr>
<th>Prusik Type</th>
<th>Pull Load (kN)</th>
<th>Locking Force (kN)</th>
<th>Max Force (kN)</th>
<th>Test Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC Static Pro</td>
<td>7.8</td>
<td>0.5</td>
<td>8.7</td>
<td>5</td>
</tr>
<tr>
<td>11mm Polyester</td>
<td>6.2</td>
<td>0.3</td>
<td>6.7</td>
<td>4</td>
</tr>
<tr>
<td>3-wrap Prusik</td>
<td>5.8</td>
<td>0.3</td>
<td>6.1</td>
<td>4</td>
</tr>
<tr>
<td>Nylon</td>
<td>7.2</td>
<td>0.5</td>
<td>7.8</td>
<td>5</td>
</tr>
</tbody>
</table>

Note: Prusik from test slip test was removed from the test rope and pulled to failure test in end: 21.9 kN.

Summary Data – VT Prusik 6/1

<table>
<thead>
<tr>
<th>Prusik Type</th>
<th>Pull Load (kN)</th>
<th>Locking Force (kN)</th>
<th>Max Force (kN)</th>
<th>Test Success</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC Static Pro</td>
<td>7.2</td>
<td>14.5</td>
<td>14.1</td>
<td>11</td>
</tr>
<tr>
<td>VT Prusik</td>
<td>6/1 Prusik</td>
<td>11.4</td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Technora Nylon</td>
<td>11.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NE KMMI</td>
<td>11.4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All 11mm</td>
<td>11.4</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Bluewater VT Prusik 6/1

Summary Data – VT 3-wrap Prusik

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Wraps</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC Static Pro</td>
<td>3.9 kN</td>
<td>10.5 kN</td>
<td>7.2 kN</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>
| Sterling
Superstatic | Bluewater
VT Prusik | 3-wrap
Prusik | Technora/Nylon |
| NE KMIII
diphenylphosphinate | All 11 mm |

Observations – VT 3-wrap Prusik

- Tests using CMC Static Pro had nearly identical slip forces as the tests using the Nylon 3-wrap Prusik (on the same rope).
- The maximum slip force on the New England KMIII host rope was less than the other two rope models minimum recorded slip force.
- No visible damage on any of the tests.

Bluewater VT 3-wrap Prusik

Summary Data – RIT 900 3-wrap Prusik

<table>
<thead>
<tr>
<th>Test Name</th>
<th>Low</th>
<th>Medium</th>
<th>High</th>
<th>Wraps</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>CMC Static Pro</td>
<td>10.0 kN</td>
<td>17.0 kN</td>
<td>13.6 kN</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>
| Sterling
Superstatic | RIT 900
Prusik | Polypropylene
Prusik | Technora |
| NE KMIII
diphenylphosphinate | All 11 mm |

Observations – VT Prusik 6/1

- The maximum slip force on the New England KMIII host rope was less than the other two rope models minimum recorded slip force.
- The KMIII host rope (used) also had the only visibly damaged rope on a test. 360 degree sheath damage at 10.7 kN.
Sterling RIT 900 3-wrap Prusik

- NE KMII
- CMC Static Pro
- Sterling Superstatic

Observations - RIT 900 3-wrap Prusik

- The RIT 900 3-wrap Prusik slipped at significantly higher forces than the 3-wrap Nylon or VT Prusiks
- Slip forces were similar to the VT 6/1 on the CMC and Sterling host ropes
- Nearly every test resulted in damage to the hitch material and/or the host rope

Drop Testing

- BCCTR Belay Competence Drop Test Method (i.e., 1m drop or 3m rope; 300 kg max; 5 ft/min drop; 5.8 (kN MAP), etc.)
- Data captured with a load cell set for 2400 Hz
- Combination of new/used materials
- 28 tests conducted
  - comprising the summary data
  - "quick look" and a robust data set
  - other "quick look" drops not included in count

Bluewater VT Prusik 6/1

- Test # D911114-0

<table>
<thead>
<tr>
<th>Test</th>
<th>NE KMII</th>
<th>VT Prusik</th>
<th>Gf</th>
<th>Max Slip</th>
<th>Pass?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>331.5</td>
<td>395.5</td>
<td>8.9</td>
<td>10.9</td>
<td>Fail</td>
</tr>
</tbody>
</table>

BCCTR BCDTM

- Pass? No
- Fail?

Summary Data – VT Prusik 6/1

<table>
<thead>
<tr>
<th>Test</th>
<th>NE KMII</th>
<th>VT Prusik</th>
<th>Gf</th>
<th>Max Slip</th>
<th>Pass?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>331.5</td>
<td>395.5</td>
<td>8.9</td>
<td>10.9</td>
<td>Fail</td>
</tr>
</tbody>
</table>

BCCTR BCDTM

- Pass? No
- Fail?

However...

A variety of "quick look" examinations using VT Prusks configured as:

- 3/A (i.e., symmetrical 3-wrap Prusk)
- 4/2
- 5/2
- and 5/1

All failed to pass the BCDTM due to excessive stop distances (≥ 100 cm)
**RIT 900 3-wrap Tandem Prusiks**

Test # D091814-14

<table>
<thead>
<tr>
<th>Surface</th>
<th>Equipment</th>
<th>Height (m)</th>
<th>Force (kg)</th>
<th>Type (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Sterling Tandem Prusik 11mm</td>
<td>• RIT 900 Prusik 3-wrap</td>
<td>2</td>
<td>300.5</td>
<td>12.9</td>
<td>No visible damage</td>
</tr>
</tbody>
</table>

BCCTR BCDTM

• Pass? ✖
• Fail? ☑

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**Summary Data**

**RIT 900 3-wrap Tandem Prusiks**

<table>
<thead>
<tr>
<th>Surface</th>
<th>Equipment</th>
<th>Height (m)</th>
<th>Force (kg)</th>
<th>Type (m)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>• NE RMBR Pin</td>
<td>• RIT 900 Tandem Prusik 3-wrap</td>
<td>15</td>
<td>339.5</td>
<td>9.8 – 14.8</td>
<td>No visible damage</td>
</tr>
</tbody>
</table>

BCCTR BCDTM

• Pass? ✖
• Fail? ☑

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**Other drop testing**

A load test of a 1.25m drop using CMC Static Pro 11mm and RIT 900 Tandem 3-wrap Prusiks resulted in sheath rupture of the host rope.

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**General observations...**

- In slow pull, the RIT 900 3-wrap Prusik and the VT 6/1 Prusik seem to slip at a higher force that an 8mm Nylon 3-wrap Prusik (on same host ropes)
- In drop testing, the failures appear to involve host rope degradation versus not catching (i.e., high material properties the host rope vs. wire versus)

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**Special thanks to:**

- Kevin Koprek, Mark Miller of RIR and Rich Carlson of Canyons & Crags for initiating the testing on aramid fiber rope grabs
- CMC Rescue and Joe Flachman
- Sterling Rope and Sam Morton & Matt Hunt
- The ITRC community